Clouds and Contrails

Citizen Science Observations Collocated with Satellite Data

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RESEARCH OPPORTUNITIES IN SPACE AND EARTH SCIENCES – 2019 (ROSES-2019)

(i) Citizen science

Citizen science is a form of open collaboration in which individuals or organizations participate voluntarily in the scientific process. Proposers to any ROSES program element are invited to incorporate citizen science and crowdsourcing methodologies into their submissions, where such methodologies will advance the objectives of the proposed investigation. The current SMD Policy on citizen science~~, that~~ describes standards for evaluating proposed and funded SMD citizen science projects. For more information see Section 3 H.R.6414 - Crowdsourcing and Citizen Science Act of 2016, which authorizes federal agencies to utilize crowdsourcing and citizen science and the https://science.nasa.gov/citizenscientists webpage, that provides information about existing SMD-funded projects, including how to sign up for the NASA-SOLVE email listserve.

Full ROSES 2019 Summary of Solicitation (PDF), https://tinyurl.com/y2fkrfnb

Date: Tuesday, April 23, 2019 at 2:41 PM
To: "'smd@listsrv2.nasaprs.com'" smd@listsrv2.nasaprs.com
Subject: [smd] Community Announcement: ROSES Funding for Citizen Science

Community Announcement: ROSES Funding for Citizen Science

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This year we are highlighting the new Science Mission Directorate (SMD) policy inviting investigators to incorporate citizen science into their research. ROSES proposers will be asked to answer a question in NSPIRES to indicate if their proposals incorporate citizen science components.

Proposals submitted to any ROSES-2019 call, unless otherwise noted in the program element, may be entirely or partially citizen science-based…

Proposers are encouraged to read Science Policy Document SPD-33… SPD-33 is available here: https://tinyurl.com/yyvpzpxd

Additional funding may be available for proposals incorporating citizen science.

…

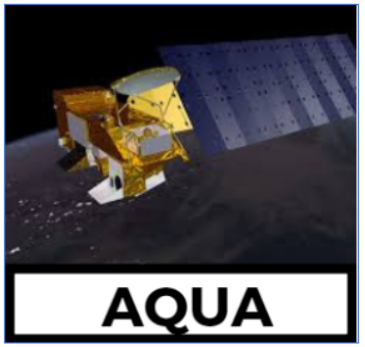
GLOBE Program: Citizen Science Data

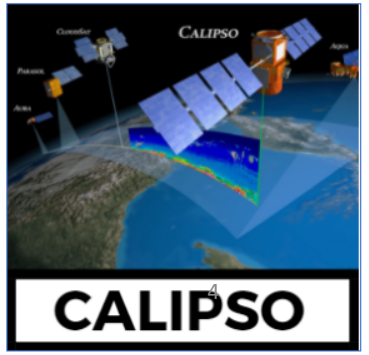
The **G**lobal **L**earning and **O**bservations to **B**enefit the **E**nvironment (GLOBE) Program is a NASA-funded international science and education program.

Provides opportunities to participate in data collection and the scientific process, and contribute meaningfully to our understanding of the Earth system and global environment.

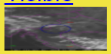
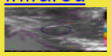
GLOBE Observer app allow easy method of reporting Earth system observations for participants of all ages and skills

GLOBE Clouds is LaRC specialty – collocated ground cloud obs. with satellite data





NASA Cloud Observation and Satellite Match

Satellite		GEO	Aqua	Terra	Your Observation
Universal Date/Time 2019-05-02		11:10	10:57	10:52	11:00
Latitude Range Longitude Range		45.17 to 45.81 15.24 to 15.88	45.06 to 45.86 15.23 to 16.03	45.09 to 45.89 15.1 to 15.9	**Latitude 45.48** **Longitude 15.55**
Total Cloud Cover		Scattered 41.67%	Isolated 20.90%	Isolated 23.25%	**Scattered (25-50%)**
HIGH	Cloud Cover Cloud Altitude Cloud Phase Cloud Opacity	No Clouds	Few (0.37%) 8.73 (km) Ice 227.01 (K) Transparent	No Clouds	
MID	Cloud Cover Cloud Altitude Cloud Phase Cloud Opacity	Isolated 11.11% 2.37 (km) Water 279.13 (K) Translucent	Few (0.10%) 5.79 (km) Ice 251.55 (K) Transparent	Few (6.35%) 3.18 (km) Ice 269.56 (K) Transparent	
LOW	Cloud Cover Cloud Altitude Cloud Phase Cloud Opacity	Scattered 30.56% 1.07 (km) Water 287.39 (K) Transparent	Isolated 20.43% 1.58 (km) Mixed 278.21 (K) Transparent	Isolated 16.90% 1.31 (km) Water 280.79 (K) Translucent	 Cumulus Scattered (25-50%) Translucent
Corresponding NASA Satellite Images. Click to view image --->		***METEOSAT-11*** Visible  Infrared  GEO Tutorial	***MODIS*** Rapid Response  Worldview  MODIS Tutorial	***MODIS*** Rapid Response  Worldview  MODIS Guide	Sky Visibility : Clear Sky Color : Blue

Are there any comments you would like to add? Be sure to add the name of the satellite for our record.

Submit Comment

Surface Conditions

Snow/Ice	No
Standing Water	No
Muddy	No
Dry Ground	Yes
Leaves on Trees	Yes
Raining or Snowing	No

GLOBE Observers Caught in Saharan Dust Storm

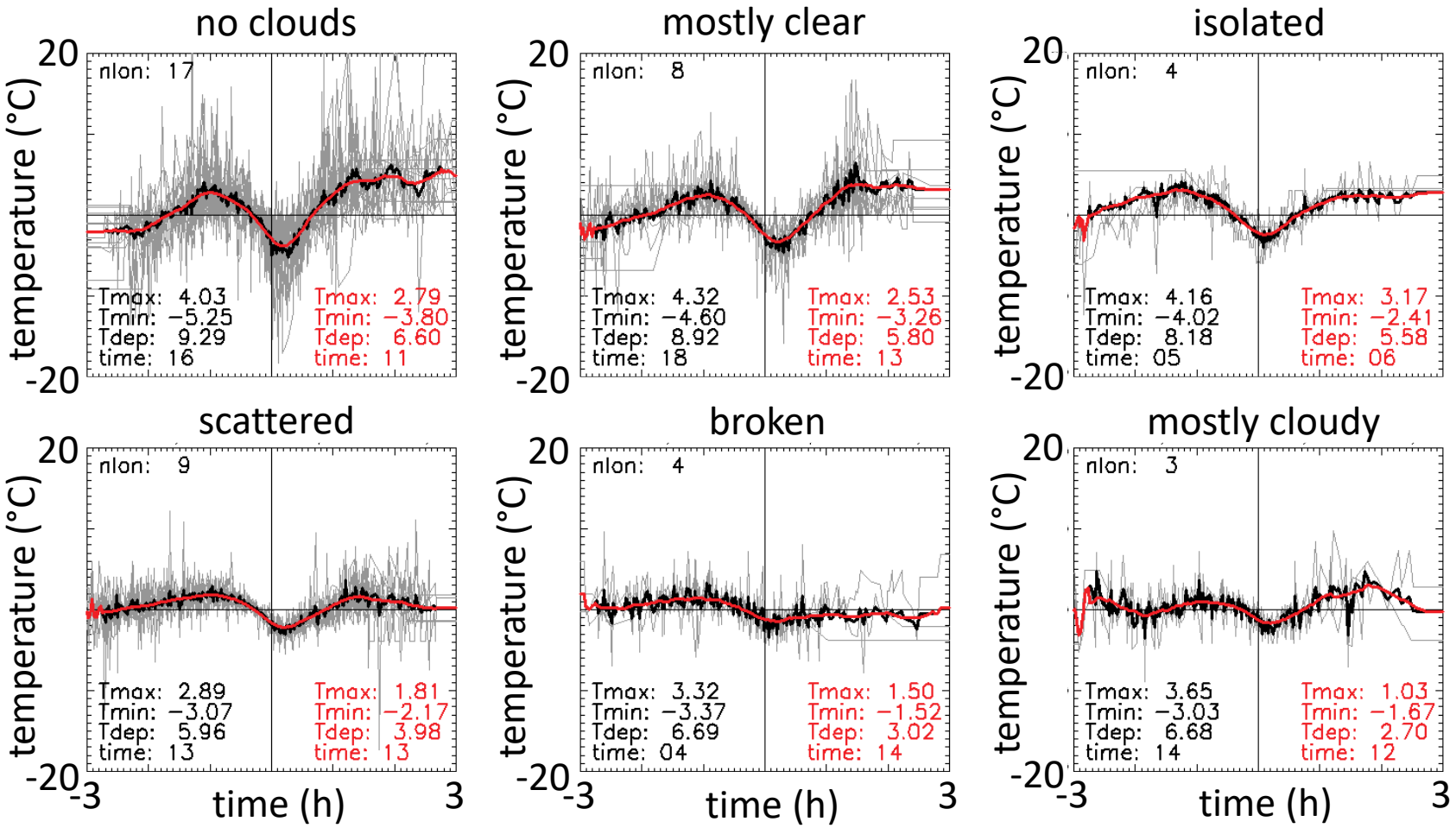
Source: NASA WorldView, MODIS/Aqua & Terra, Suomi NPP

(Almost) Completed Work – 2017 Solar Eclipse Analysis

- GO participants collected cloud cover and temperature data
- Submitted a paper to the Journal of Applied Meteorology and Climatology (JAMC) late last year discussing analysis results
- Currently on the second round of revisions

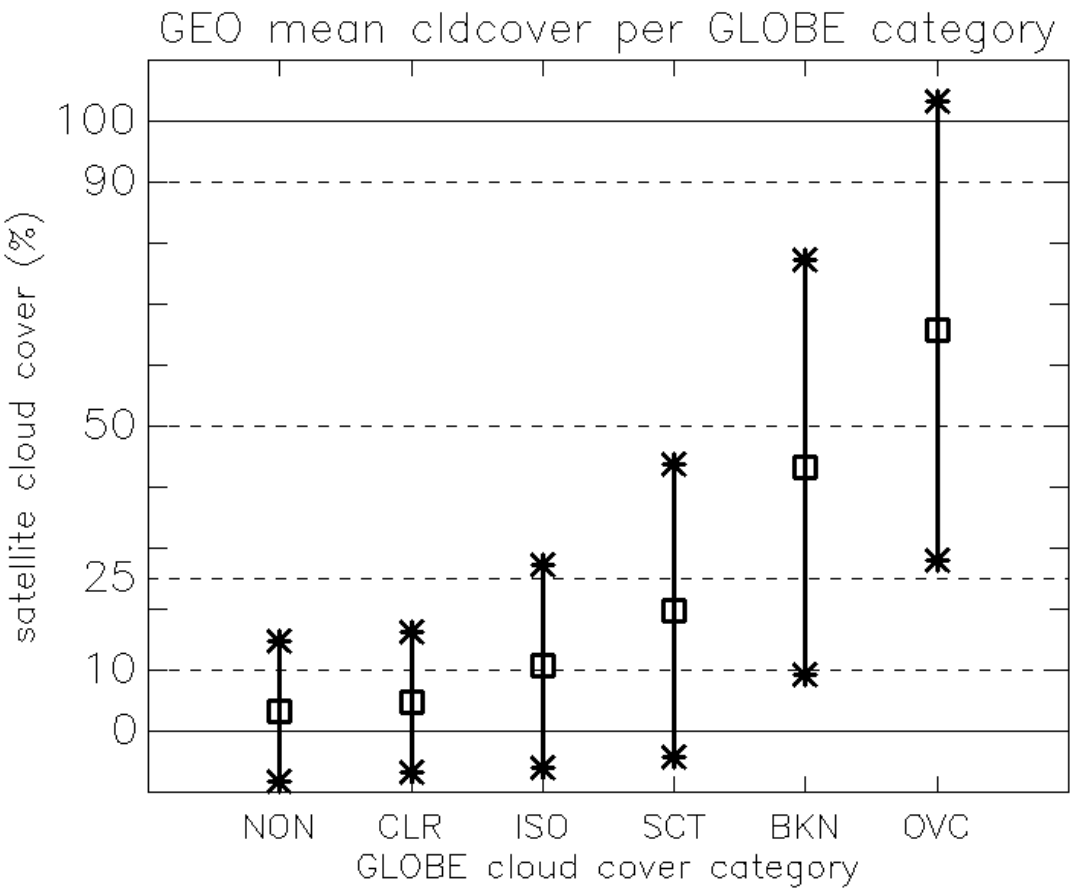
Main result: Greater Cloud Cover Reduces Temperature Perturbation

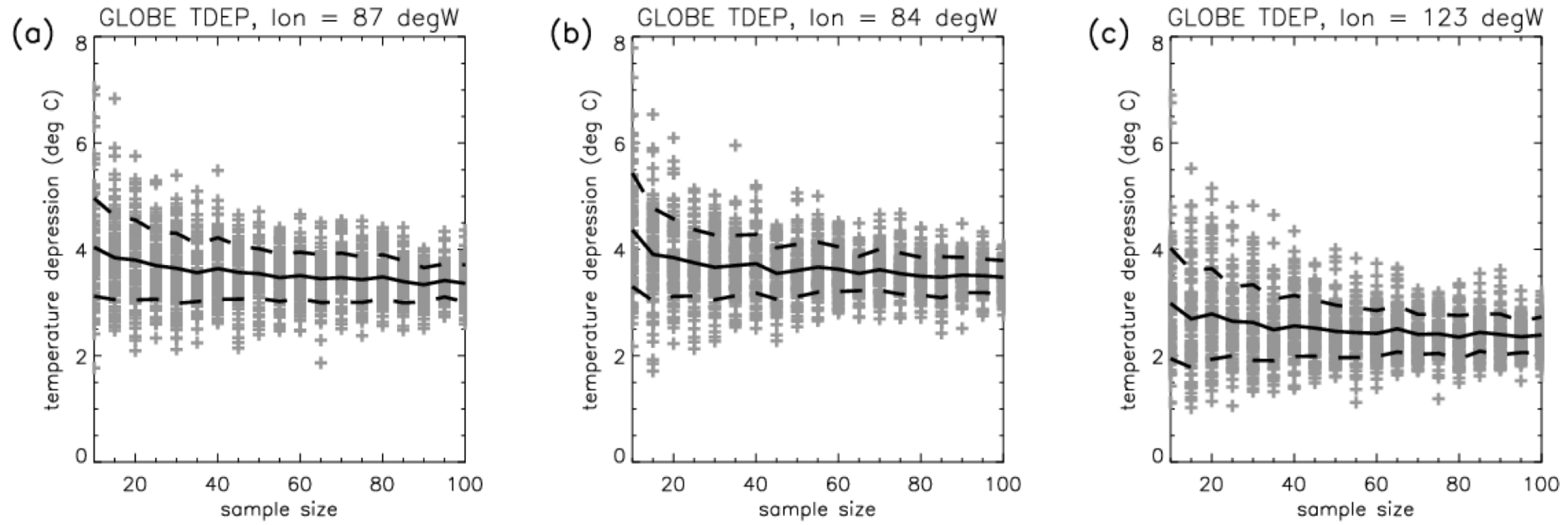
Cloudy skies have 40% smaller perturbation than clear skies



All data are from citizen scientists

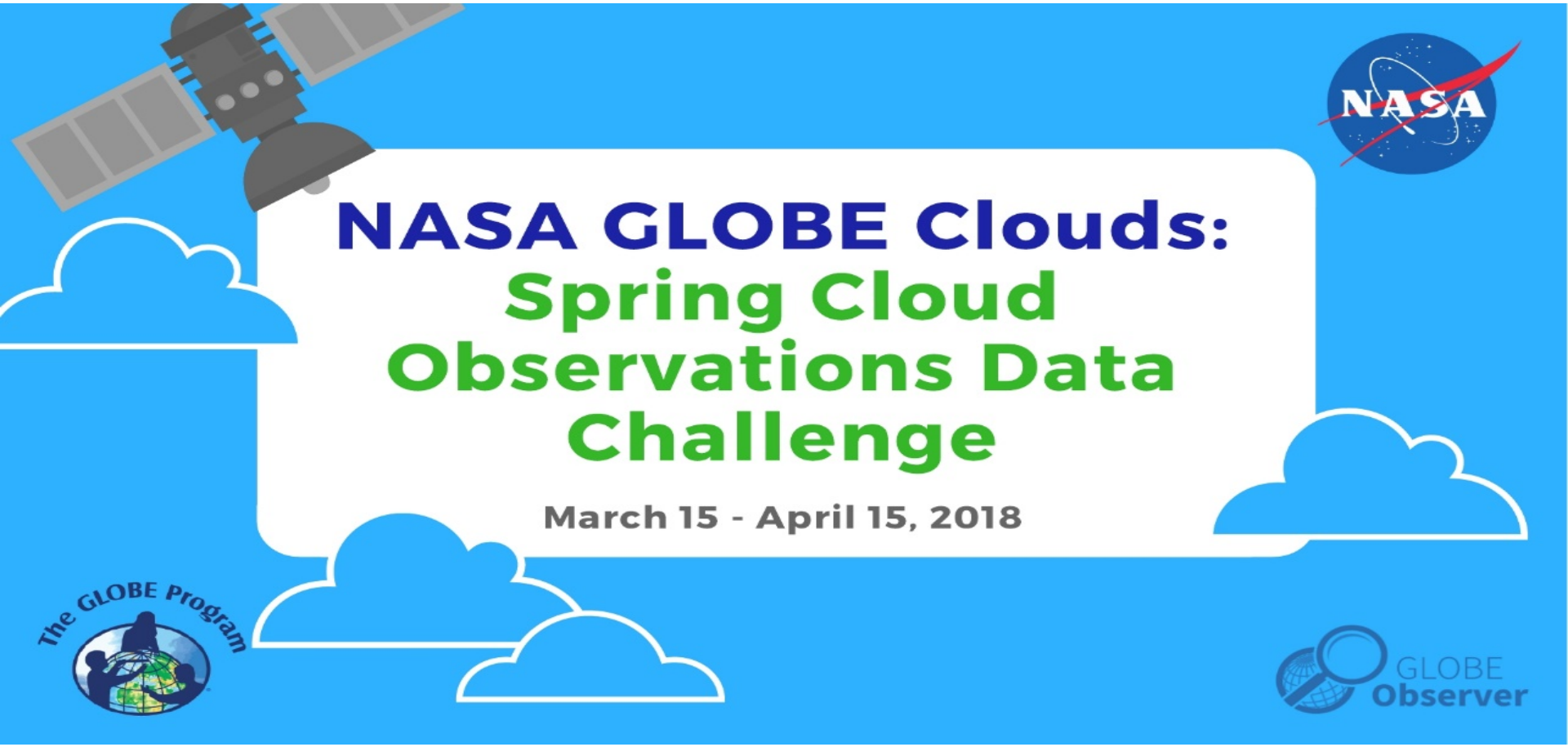
- Co-located satellite data shows possible overestimate of GO cloud cover observations
- However, these disagreements cannot be used to explain over aspects of the paper results
- The process of comparing satellite data with GO obs. will serve as a starting point for future GO data analysis





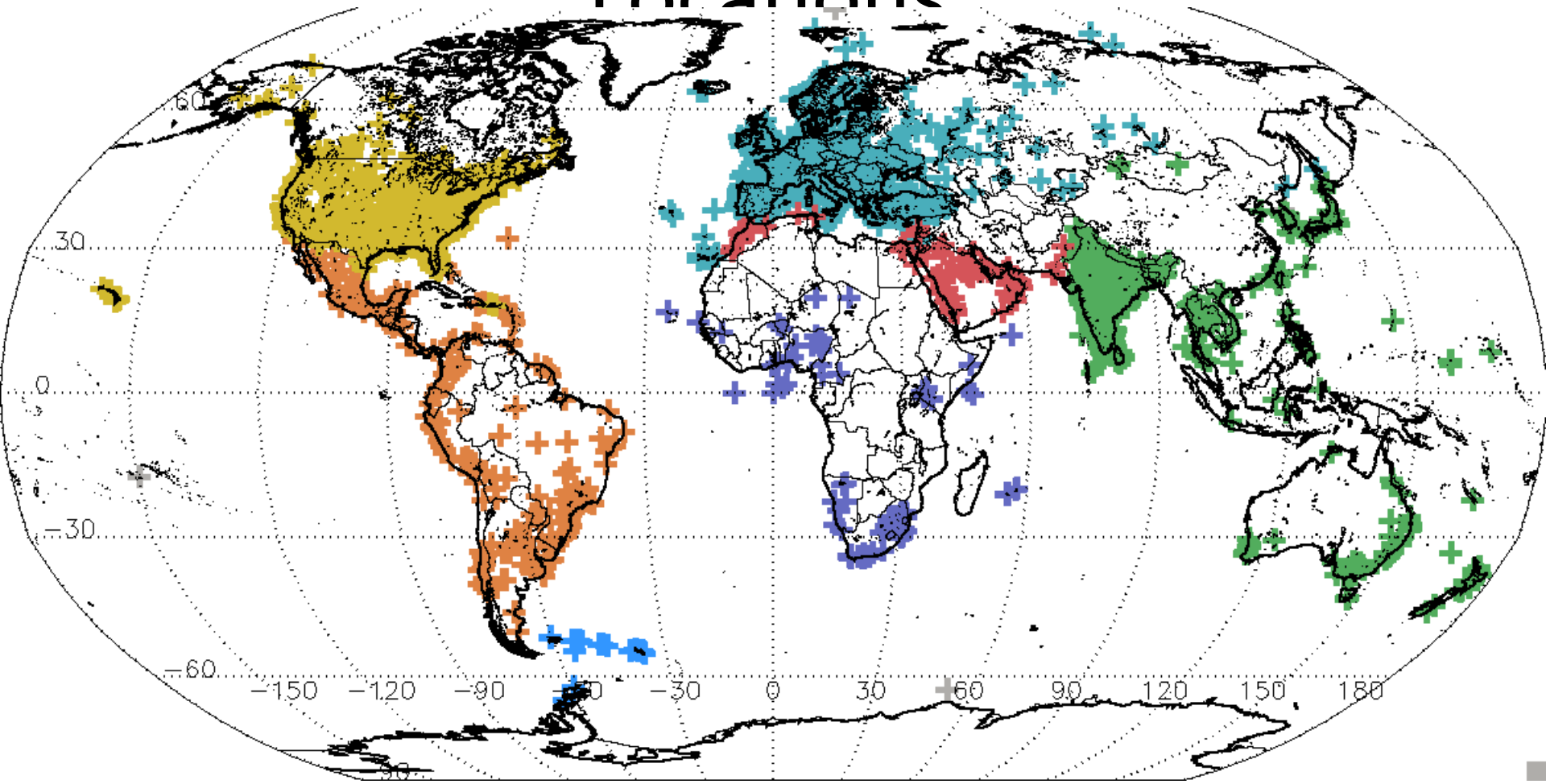
- Question: How much is the uncertainty of the results affected by the number of data points?
- Monte Carlo approach:
  1. randomly subset the dataset to a small number of data points, calculate the results
  2. repeat a hundred times for a given sample size
  3. increase sample size, repeat 1 and 2
- Plotting the range of results by sample size reveals the decrease of uncertainty as sample size increases
- Techniques like this will be very useful for quantifying uncertainty of GO data in future projects

Current Work – Analysis of 2018 Spring Data Challenge observations

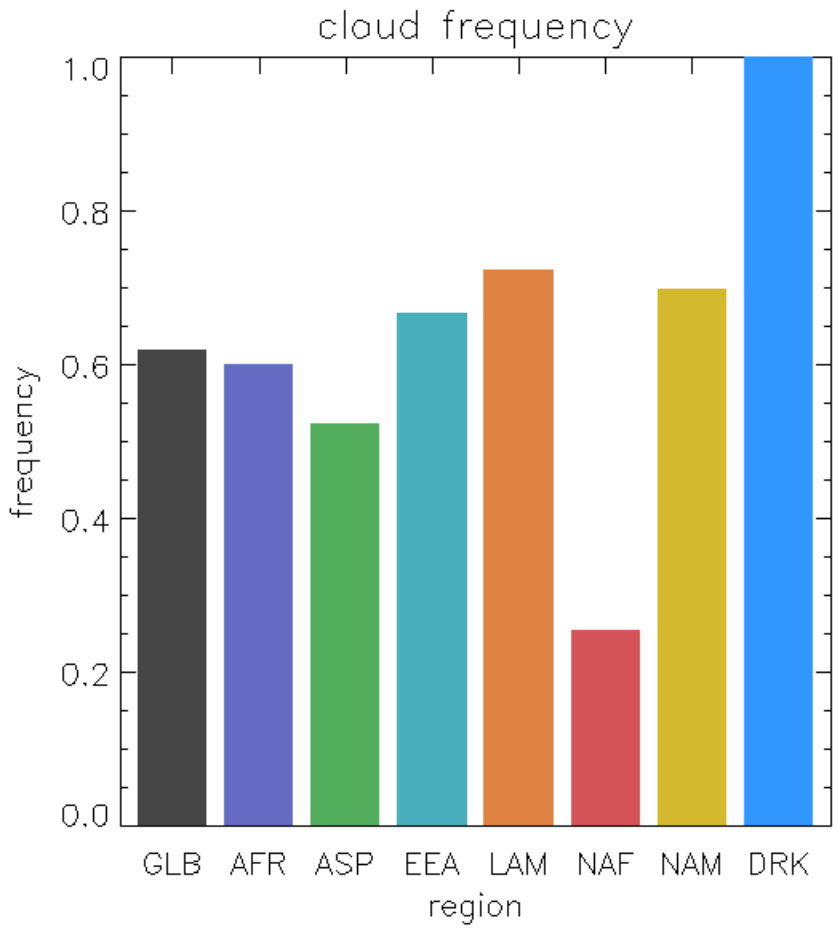


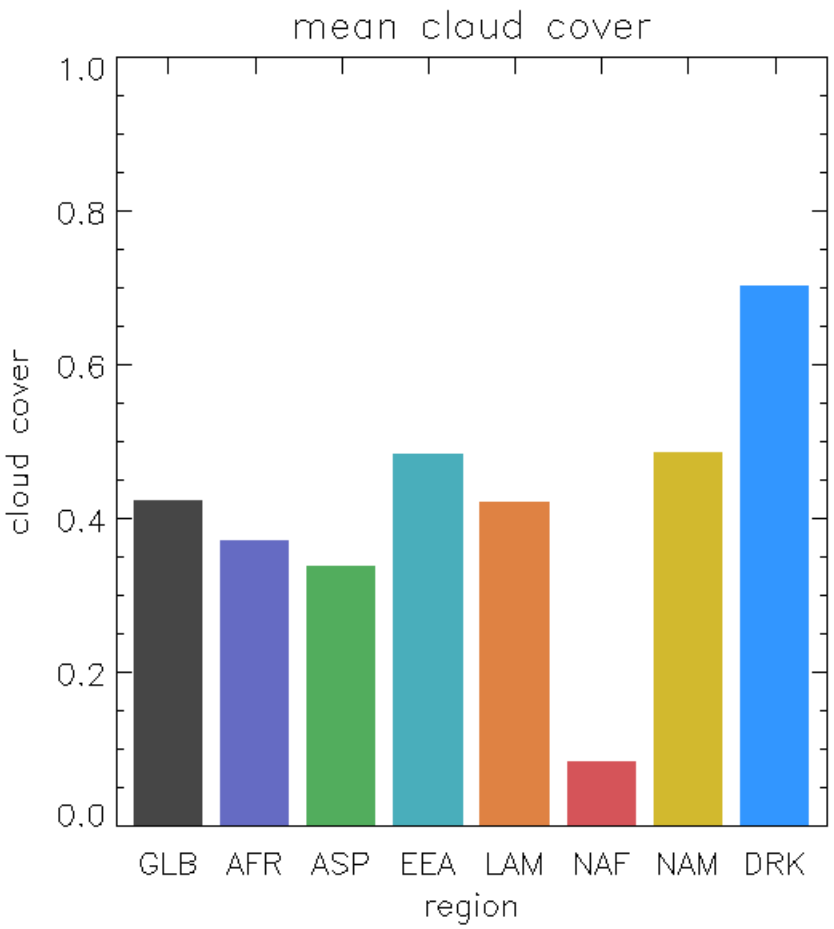
- Month-long campaign to collect cloud data worldwide
- Garnered major public interest and media recognition

Data Challenge Observing Locations

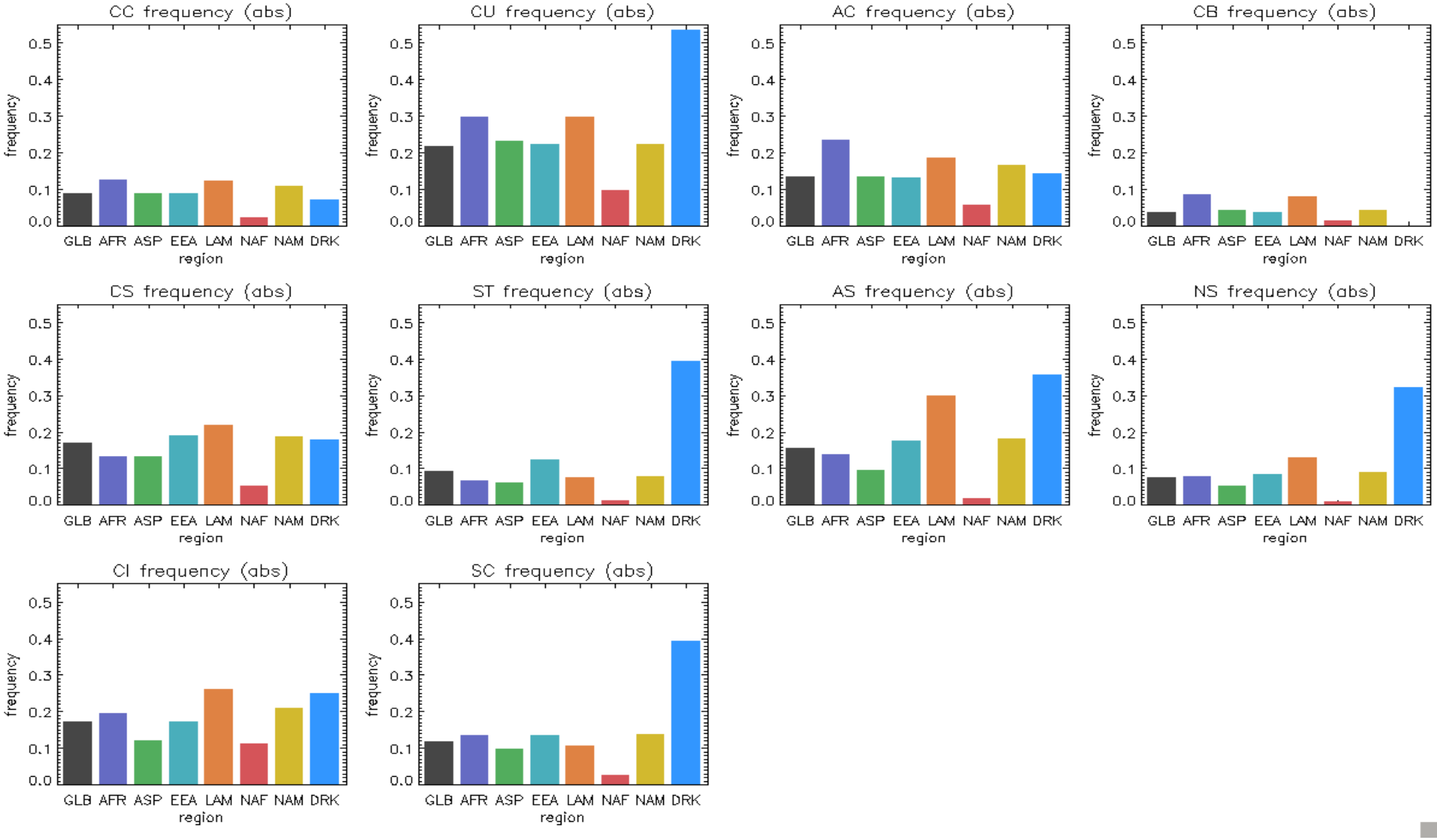


- 55,185 obs., 33,974 collocated satellite obs.
- All seven continents, including Antarctica
- Data are currently subdivided by geopolitical region

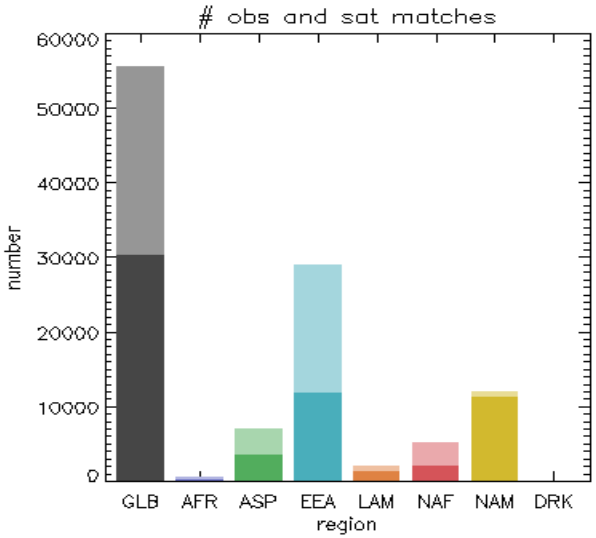


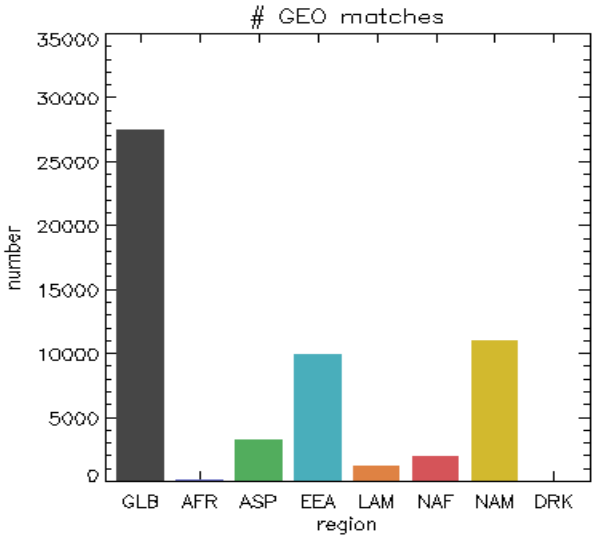


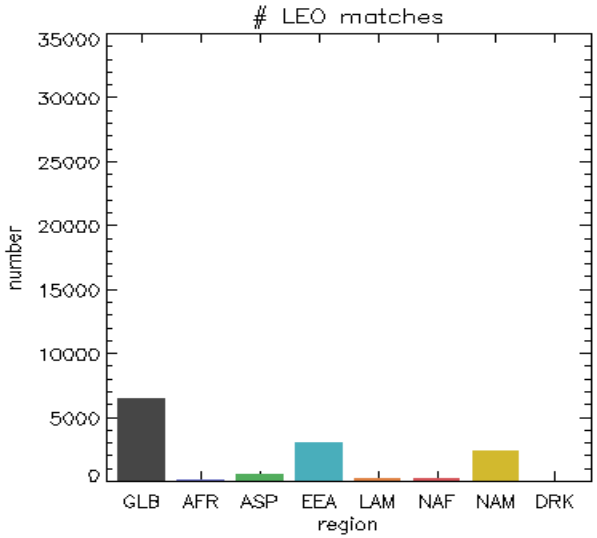
- Cloud frequency – how often the presence of clouds was reported
- Mean cloud cover – the frequency of clouds multiplied by the coverage
- Can do by vertical layer as well!

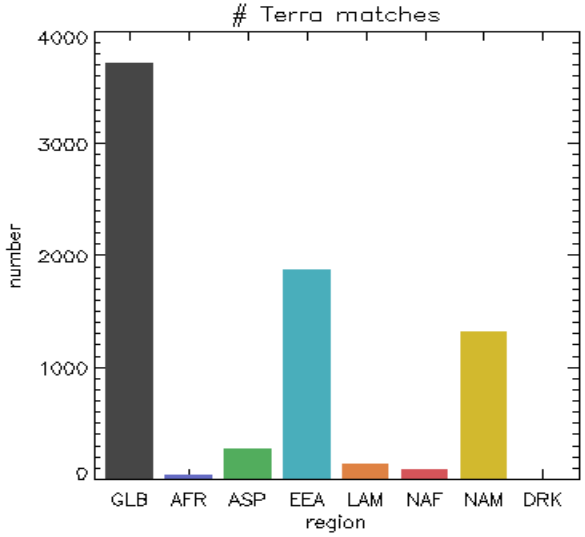


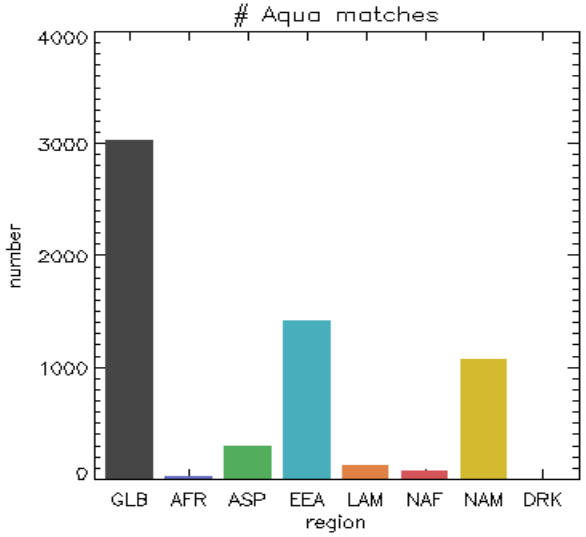
- Cloud type tells us about meteorological processes producing clouds
- Can compare cloud cover and type with meteorological conditions (from ground stations, satellite, and/or reanalysis)

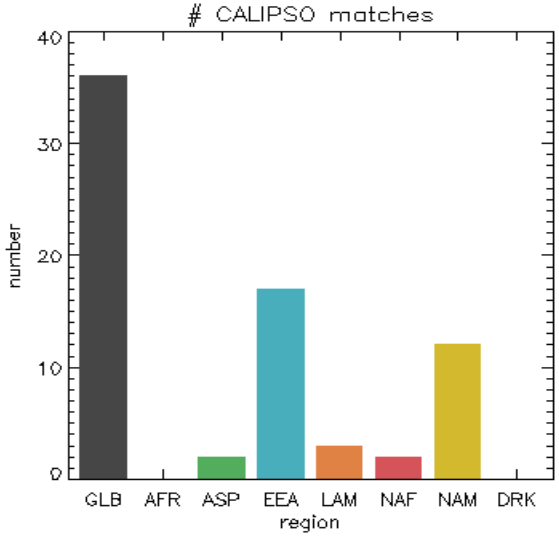












- Half of obs. are collocated with satellite data
- ~20% are from LEO (Terra/Aqua/CALIPSO)
- Many opportunities for ground observations/sat comparison

Current Work - Contrails

- Contrails have small but significant effect on Earth radiation
- Difficult to spot from space, but easier on ground
- Match contrail data with vertical humidity profiles to understand conditions favorable for contrail formation
- GLOBE Clouds is running test program with student observations

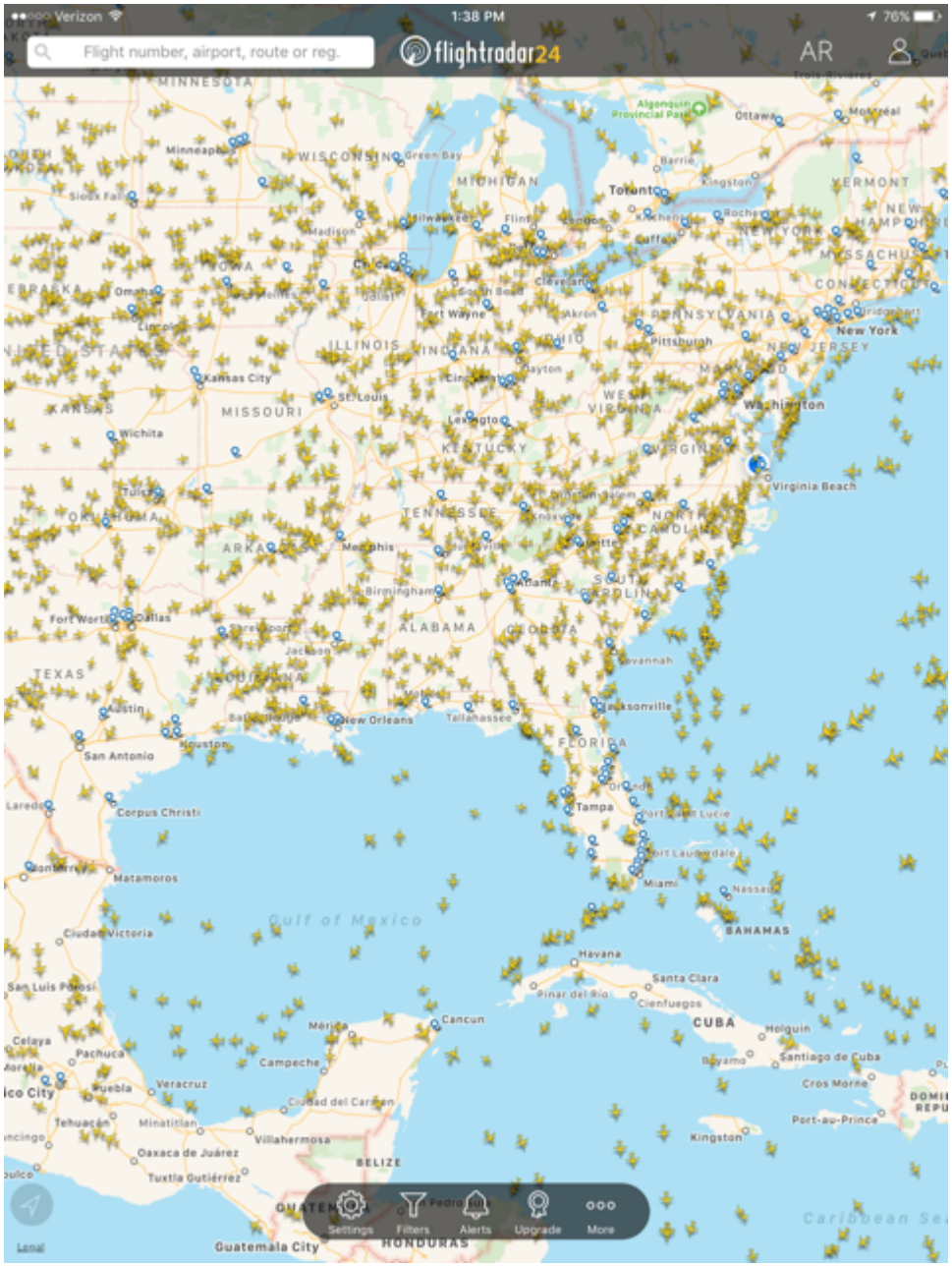
Participants report information about both the properties of the contrails and the aircraft producing the contrails

Date Example 08292018 for August 29, 2018 (Value should match the time of cloud observations entered in GLOBE)	**Time** Example 10:49am (Value should match the time of cloud observations entered in GLOBE)	**Airplane Type** Example E75L (Please include those that produce and do not produce contrails)	**Airplane Calibrated Altitude or Height (ft)** Example 34,000 (Use the app to get this information)	**Airplane Track (degrees)** Example 28 Use the app. Value should be between 0-359.	**Contrail Type** Click on the arrow and choose one of the options.	**Comments (Optional)**
8312018	11:40 AM	Boeing 737-7H4	9,825	119	No contrail	
9042018	12:05 PM	N61XP	25000	165	PS or persistent	
9062018	9:37	na	1501	93	PS or persistent	not many clouds
9062018	12:33 PM	na	2400	138	S or short-lived	not many clouds
90718	1:36 PM	Boeing 737-7H4	8414	123	PS or persistent	lots of cirrus clouds
9102018	12:42 PM	Boeing 737-7H4	10712	102	S or short-lived	scattered skies
9112018	8:41 AM	Dymaio DA42NG	3040	109	PS or persistent	blue sky
9112018	9:37 AM	Cessna 1725	25000	60	No contrail	scattered clouds and blue sky
9112018	11:41 AM	ILM	3370	64	No contrail	lots of puffy clouds
9112018	12:34 PM	Boeing	8875	130	PS or persistent	scattered clouds
9122018	8:39 AM	Cessna	1611	343	No contrail	Sky blue

Flightradar24 App

Flightradar24 map view displays aircraft location, heading, altitude, type, and other useful data

(no military aircraft)



Different aircraft types are more/less likely to produce contrails intrinsically

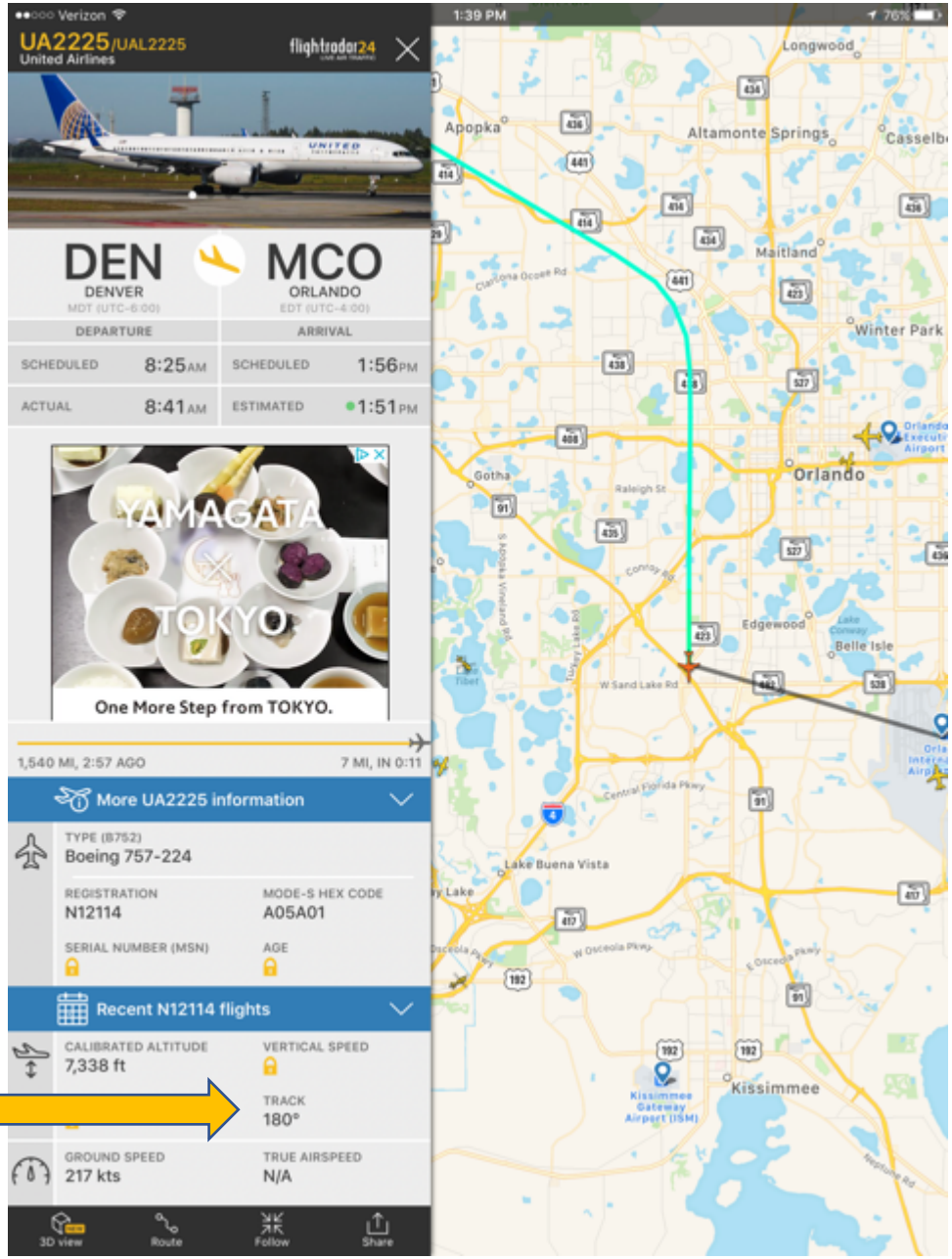
Altitude important for comparison with vertical profile data (moisture layers can be very thin)

Track can be used in collocating ground observations with satellite data (future work)

Airplane Type

Calibrated Altitude

Track (heading)



Flightradar24 has an augmented reality function that shows all the airplanes around you.

This is also useful for IDing aircraft that do not produce contrails, and are hard to see.

GLOBE Clouds Team

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